JC07 Rec'd PCT/PTO 22 FEB 2002

FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY 'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		021645-000100US
		U S. APPLICATION NO. (If known, see 37 CFR 1 5) 10/069346
INTERNATIONAL APPLICATION NO. PCT/NO00/00279	INTERNATIONAL FILING DATE August 24, 2000	PRIORITY DATE CLAIMED August 24, 1999

TITLE OF INVENTION
A HYBRID RISER CONFIGURATION

APPLICANT(S) FOR DO/EO/US
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Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST submission of items concerning a filing under 35 U.S.C. 371.**
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 36 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 37(c)(2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   a. ☒ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.2 and 35 U.S.C. 1.821 – 1.825.
18. ☐ A second copy of the published international application under 36 U.S.C.
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

International Search Report, ADS
International Preliminary Examination Report

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I/S/ Application no. (if known, see 37 CFR 1.5) 10/069346	INTERNATIONAL APPLICATION NO PCT/NO00/00279	ATTORNEY'S DOCKET NUMBER 021645-000100US

21. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(A) (1) – (5)):	CALCULATIONS PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.492) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search report prepared by the EPO of JPO **$890.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$740.00**
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	20 - 20 =		x **$18.00**	$
Independent claims	1 -3 =		x **$84.00**	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **280.00**	$
TOTAL OF ABOVE CALCULATIONS =				$
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$
SUBTOTAL =				$
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFT 1.492(f).				$
TOTAL NATIONAL FEE =				
Fee for recording the enclosed assignment (37 CFR 1.2(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$
TOTAL FEES ENCLOSED =				$740.00
			Amount to be refunded:	$
			charged:	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 20-1430 in the amount of $740.00 to cover the above fees.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 20-1430. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

02/22/02
DATE

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24,491
REGISTRATION NUMBER

Application Data Sheet

Application Information

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Number of copies of CRF::	
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Total Drawing Sheets::	5
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Variety denomination name::	
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Contract or Grant Numbers One::	
Secrecy Order in Parent Appl.::	No

Applicant Information

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PCT	WO 01/14687	August 24, 2000
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. National Phase of:
PCT/NO00/00279

ARNE SELE, et al.

Application No.: Not yet assigned

Filed: Herewith

For: A HYBRID RISER CONFIGURATION

PRELIMINARY AMENDMENT

San Francisco, CA 94111
February 22, 2002

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to the examination of the above-referenced application, please enter the following amendments and remarks.

IN THE CLAIMS:

Please delete claims 1-10.

Please substitute the following new claims 11-30:

(new) 11. A hybrid riser configuration having a submerged tower (4) comprising a plurality of riser pipes (10) substantially inserted in guide conduits (9), and also having buoyancy means (6) and tethering tension means, the riser pipes (10) and guide conduits (9) being connected to a base (5) anchored to the ocean floor, wherein a plurality of the guide conduits (9) are acting as multiple tethers, each guide conduit (9) further acting as a radial constraint in elastic spiral deformation of the riser pipe (10) inside.

(new) 12. A hybrid riser configuration according to claim 11, wherein the riser pipes (10) and guide conduits (9) are rigidly connected both to the base (5) and the buoyancy means (6) of the riser configuration.

(new) 13. A hybrid riser configuration according to claim 11, wherein the material of the guide conduits (9) comprises aluminium or a similar light metal.

(new) 14. A hybrid riser configuration according to claim 11, wherein the riser configuration is protected by sacrificial anodes.

(new) 15. A hybrid riser configuration according to claim 11, wherein during tow-out and installation, the guide conduits (9) provide necessary buoyancy to make the riser configuration, except the base (5) and buoyancy means (6), near neutrally buoyant.

(new) 16. A hybrid riser configuration according to claim 12, wherein the material of the guide conduits (9) comprises aluminium or a similar light metal.

(new) 17. A hybrid riser configuration according to claim 12, wherein the riser configuration is protected by sacrificial anodes.

(new) 18. A hybrid riser configuration according to claim 12, wherein during tow-out and installation, the guide conduits (9) provide necessary buoyancy to make the riser configuration, except the base (5) and buoyancy means (6), near neutrally buoyant.

(new) 19. A hybrid riser configuration according to claim 13, wherein the riser configuration is protected by sacrificial anodes.

(new) 20. A hybrid riser configuration according to claim 13, wherein during tow-out and installation, the guide conduits (9) provide necessary buoyancy to make the riser configuration, except the base (5) and buoyancy means (6), near neutrally buoyant.

(new) 21. A method for installing a riser configuration having a submerged tower (4) comprising a plurality of riser pipes (10) substantially inserted in guide conduits (9) and also having a buoyancy tank (6) and gravity base (5) connected by said riser pipes (10) and guide conduits (9), comprising the steps of:

- fabricating a bundle (4) of guide conduits (9) and riser pipes (10) on a roller bed or rail bed from which it can be launched,

- connecting the buoyancy tank (6) and gravity base (5) to opposite ends of said bundle,

- sealing at least a plurality of the guide conduits (9) and riser pipes (10) of the bundle (4),

- launching the resultant structure and connecting the buoyancy tank and gravity base ends of the structure to respective towing vessels (17) via towing wires (18),

- flooding the buoyancy tank (6) to provide it with substantial negative buoyancy so that both the tank (6) and the base (5) will act as clump weights,

- towing the structure (4,5,6) to the offshore location for its installation as a sub-surface tow while maintaining sufficient angle and tension in the towing wires (18) to maintain substantial tension in the pipe bundle (4),

- lowering the base (5) end of the structure (4-6) by paying out the towing wire connected to the base (5),

- permitting water to enter the spaces formed between the riser pipes (10) and their respective guide conduit (9) when the base (5) has reached a predetermined depth in order to limit the differential pressure across the wall of the guide conduits (9),

- continuing lowering the base end of the structure until the structure is perpendicular and suspended from the towing wire (18) connected to the buoyancy tank (6), and

- lowering the structure to allow the base (5) to penetrate the bottom (2) mud-line and anchoring the base to the ocean floor, and removing the water ballast and towing wire (18) from the buoyancy tank, thus providing tension in the guide conduits (9).

(new) 22. A method according to claim 21, wherein a motion compensating system is employed in the towing wire (18) between the buoyancy tank (6) and surface vessel. (17).

(new) 23. A method according to clam 21, wherein the guide conduits (9) are fabricated by welding together sections of aluminium pipe using friction stir welding.

(new) 24. A method according to claim 21, wherein said guide conduits (9) are made by joining sections of aluminium pipe which are made with a longitudinal seam welded by means of friction stir welding.

(new) 25. A method according to claim 21, wherein at least some of the annular spaces between the riser pipers (10) and the corresponding guide conduits (9) are filled with a gel after expelling any water having entered said spaces during installation of the structure.

(new) 26. A method according to claim 22, wherein the guide conduits (9) are fabricated by welding together sections of aluminium pipe using friction stir welding.

(new) 27. A method according to claim 22, wherein said guide conduits (9) are made by joining sections of aluminium pipe which are made with a longitudinal seam welded by means of friction stir welding.

(new) 28. A method according to claim 22, wherein at least some of the annular spaces between the riser pipes (10) and the corresponding guide conduits (9) are filled with a gel after expelling any water having entered said spaces during installation of the structure.

(new) 29. A method according to claim 23, wherein said guide conduits (9) are made by joining sections of aluminium pipe which are made with a longitudinal seam welded by means of friction stir welding.

(new) 30. A method according to claim 23, wherein at least some of the annular spaces between the riser pipes (10) and the corresponding guide conduits (9) are filled with a gel after expelling any water having entered said spaces during installation of the structure.

REMARKS:

Claims 11-30 are pending.

Amendment is made to eliminate all multiple dependencies from the claims, thereby avoiding the need to pay the multiple dependent surcharge.

Respectfully submitted,

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A HYBRID RISER CONFIGURATION

FIELD OF THE INVENTION

The present invention relates to a hybrid riser configuration, primarily for offshore hydrocarbon services, as defined in the preamble of claim 1.

BACKGROUND

The hybrid riser concept has developed from top tension risers. The principal feature is that it accommodates relative motion between a floating structure and a rigid metal riser by connecting them with flexible jumpers. The first hybrid riser installed, and so far the only, was a single riser anchored to the structure with a tensioned cable. Current concepts mainly involve multiple risers with tension provided by submerged buoyancy anchored by a tether.

The principle advantage of hybrid risers tensioned by submerged buoyancy is that they are much less exposed to wave induced cyclic loads and are not excited significantly by vessel motion either. The challenge of such designs is to accommodate the relative deformation between the central tether and the risers. The risers are subjected to temperature, internal pressure, and lateral deflection, which give rise to relative deformation.

Several solutions accommodating these relative deformations can be envisioned. The most efficient solution will depend on project specific conditions, and there may not be one single design solution which is more cost optimal in all cases. The most attractive solution will be the one minimizing the major cost drivers which are syntactic foam for insulation, flexible flowline connectors, flexible jumpers, offshore assembly, tow-out, and offshore installation.

OBJECT OF THE INVENTION

The object of the present invention is to accommodate relative expansion of the riser tubes in a simple and reliable manner, and to reduce cost and risk exposure in connection with fabrication and installation of a hybrid riser configuration.

BRIEF DISCLOSURE OF THE INVENTION

These and other objects are obtained by means of an arrangement characterised in the features mentioned in claim 1. The invention also provides a method as defined in claim 6.

Further advantages and embodiments are defined in the dependent claims and the following disclosure and figures relating to exemplifying embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows an elevation view of a surface vessel connected to equipment on the ocean floor by a hybrid riser embodying the present invention,

Figure 2 is a fragmentary perspective view, partly in section, of a middle portion of the riser in Figure 1,

Figure 3 is a fragmentary perspective view of the bottom part of the riser in Figure 1,

Figure 4 is a vertical cross-section through an end connection for use in the riser in Figure 1, and

Figure 5 is a schematic elevation view illustrating a method for installing the riser in Figure 1.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring to the drawings, Figure 1 shows a surface vessel 1, e.g. a production ship for crude oil, connected to equipment (not shown) on the ocean floor 2 through a hybrid riser generally designated 3 and embodying the present invention. The riser 3 comprises a riser tower 4 connected at its lower end to a base 5 at the ocean floor 2 and at its upper end to a so-called soft tank buoyancy means 6 keeping the riser tower 4 in sufficient tension to avoid global buckling thereof.

At the buoy 6 the multiple risers of the tower 4 are connected to flexible jumper hoses 7, 8, the jumpers 7 carrying produced crude oil to the production ship 1 and the jumpers 8 carrying treated product from the ship 1 to an oil export system.

Details of the riser tower 4 are shown in Figures 2 and 3, Figure 3 showing the lower part of the tower connected to the base 5 and Figure 2 showing a section of the tower, e.g. somewhat like the upper part in Figure 3, partly broken away and partly in cross-section.

The tower comprises eight guide conduits 9, preferably made of aluminium or an aluminium alloy such as Al 6082, five of which are shown in Figure 2. A plurality of these conduits, e.g. seven of them, contains a riser pipe 10 of substantial smaller diameter, as shown in the sectioned conduit in the left part of Figure 2. The conduit not containing a riser pipe may contain an umbilical and other service lines leading to equipment on the ocean floor. The diameter of the guide conduits 9 and riser pipes 10 may be 20 cm and 10 cm, respectively.

Centrally located in the tower 4 is a pipe 11, for instance made of steel, that may serve as an export conduit for products from the production ship 1. The central pipe 11

carries a number of guide plates 12 arranged at regular intervals along the riser tower 4 and clamped between connecting flanges of the central pipe 11, the guide plates carrying guide sleeves 13 for the guide conduits 9 to keep the conduits apart when deflected by current forces. The guide sleeves may contain a low friction material to facilitate axial movement of the guide conduits 9 with respect to the guide plate 12.

The soft buoyancy tank 6 constituting the top of the riser configuration according to the invention supports the guide conduits 9 and their riser pipes 10. The upper part of the guide conduits is provided with an increasing wall thickness so as to act as a stress joint. This stress joint is rigidly connected to the tank 6. A similar type of stress joint constitutes the lower part of the guide conduits 9, extending e.g. between the guide plate 12 and the base 5 shown in Figure 3. Consequently, the guide conduits 9 are rigidly connected to the base 5, thus avoiding the need for expensive flexible connections in this area.

Also the internal riser pipes 10 are rigidly connected to the base 5 and internal piping leading to respective external connections 14 spaced along the periphery of the base 5. The fixed base 5 and rigid connections 14 are cost efficient in that they permit conventional pull-in and connection of pipelines.

A principal feature of the present invention is the dual purpose served by the aluminium guide conduits 9. Firstly, the guide conduit will restrain the steel riser pipe 10 confined therein so that it can be allowed to buckle in elastic deformation when subjected to elongation caused by high temperature and internal pressure. This buckling occurs in two orthogonal planes with a 90° phase lag, thus forming a spiral in accordance with the Euler equation. This spiral form assumed by the riser pipe 10 is suggested

in Figure 2. As a result, this controlled buckling will permit the use of a relatively thin-walled riser pipe without the need for separate tensioning means. Furthermore, the individual riser pipes 10 in the riser configuration according to the invention may operate at different pressures and temperatures and, consequently, different degrees of elongation, without causing support problems since the different elongations will simply lead to varying wave lengths of the spirals.

Secondly, the aluminium guide conduits 9 serve as tethers for the buoyancy tank 6, thus doing away with the dedicated tethers used in prior art hybrid risers. Furthermore, the relatively inexpensive aluminium pipes provide necessary buoyancy at a much lower cost than the foam buoyancy otherwise required for tow-out and installation.

In normal service, the guide conduits 9 may be pressurized with a gas like air or nitrogen to prevent implosion from occuring due to the external hydrostatic pressure. It is also envisioned to fill the annular space between the riser pipe 10 and guide conduit 9 with a gel, e.g. a paraffin gel, to reduce the heat transfer between the riser pipe 10 carrying hot produced oil and the cooler guide conduit 9 having the temperature of the surrounding sea water. Several measures may be taken to avoid corrosion of the materials in the annular space, like providing the riser pipe 10 with a coating of a polymer material or spray-coating it with aluminium. The inside of the aluminium (alloy) guide conduit 9 may be subjected to an anodising process. Also, spacer ring of an insulating material may be installed at regular intervals inside the conduit to prevent metal contact with the riser pipe.

In general, while the aluminium guide conduits may be provided with sufficient corrosion allowance to allow them to act as anodes for steel end fittings of riser pipes and flexible jumpers, it is simpler to provide sacrificial

anodes to protect the entire structure. Careful analysis has shown that, contrary to common prejudice within the industry, it will be quite safe to mix steel and aluminium in a sub-sea structure like that of the present invention.

Referring now to Figure 4, the lower termination of a riser pipe 10 and its guide conduit 9 at the base 5 is shown. The tapering wall thickness of the stress joint forming the lower part of the guide conduit 9 will be apparent from the figure. Both the conduit 9 and riser pipe 10 are provided with compact end flanges, which are bolted to the flange 15 of a connecting pipe cast into the base 5 and leading to one of the connections 14 shown in Figure 3. The compact flanges may have a seal system (not shown) which allows interfacing of different materials without giving rise to galvanic corrosion or crevice corrosion on the mating faces.

Figure 4 also shows a valve 16 connected to the annulus between the conduit 9 and pipe 10. This valve controls the differential pressure between the annulus and the surrounding sea water and is set such that it will allow ingress of water into the annulus well before the differential pressure becomes high enough to crush the guide conduit 9. Also, the valve 16 serves to permit flow out of the annulus if the pressure therein should exceed the external pressure by a predetermined amount, e.g. to permit purging the annulus of sea water that may have entered the annulus. This may occur during installation of the riser configuration, as will be explained below.

The upper termination of the guide conduit 9 and riser pipe 10 may be quite similar to that shown in Figure 4, although the concrete base will of course be replaced by some other suitable structure on the soft tank 6 obvious to the skilled person.

The riser tower according to the invention may preferably be fabricated on a roller bed or rail bed from which it can be launched. The connections to the buoyancy tank 6 and foundation 5 are made during the launching process. The riser will be made nearly neutrally buoyant. To achieve this, at least some of the guide conduits 9, and preferably all the riser pipes 10, will be used for buoyancy. A heave compensator will be provided at the buoyancy tank, which will be flooded so as to act as a clump weight.

The tow-out will initially be performed as a surface or near surface tow. In deeper water it may be lowered and completed as a sub-surface tow to reduce the effect of wave forces, as illustrated in Figure 5. Here, surface vessels 17 provide a substantial tension in the towing wires 18, thus creating sufficient tension in the tower 4 to prevent its net buoyancy, whether slightly negative or positive, from severely bending the tower. When the tow reaches the installation site, the towing wire at the base 5 end is paid out so that the tower 4 is slowly up-ended while being suspended in the heave compensated towing wire 18 at the tank 6 end. When the base end of the tower has reached a certain depth, the hydrostatic pressure will be such that the differential pressure valves 16 (Figure 4) will open to let water into the annulus between the guide conduit 9 and riser pipe 10 in order to prevent the external hydrostatic pressure from imploding the conduits 9 during the remainder of the decent towards the ocean floor 2.

Once the riser tower is vertical, the base end towing wire is released and lowering will continue from the top end to allow the base 5, which may be provided with a suction skirt, to penetrate the mud-line, followed by application of suction to complete the installation of the base. When the base 5 is in place, the buoyancy tank 6 is filled with compressed air or other gas to purge the ballast water and provide tension in the combined guide conduits and tethers 9. The final step of connecting the flexible jumper hoses

7 and 8 between the buoyancy tank 6 and the production tanker 1 to complete the hybrid riser, does not form part of the present invention.

Based on historical data from the prior art, the principal risk during tow-out and installation is loss of temporary buoyancy. In the present invention, temporary buoyancy is not required since sufficient buoyancy is provided by the structure itself. Each of the guide conduits 9 consists of two compartments, the steel riser pipe 10 inside and the annular space between the riser pipe and the inside of the guide conduit. During tow-out and installation, and also in service, the flooding of one compartment can be allowed without consequence to the design.

An alternative approach to installation, although not considered the most beneficial, is offshore assembly from a drilling platform. In this case, the riser base 5 is initially hung off in a spider on the cellar deck. Guide conduit and riser pipe sections are then installed with the derrick of the drilling platform.

It will be understood that the present invention is not limited to the exemplifying embodiments shown in the drawings and discussed above, but may be varied and modified by the skilled person within the scope of the invention defined by the appended claims. Furthermore, it will be understood that the present invention provides a number of significant advantages which may be summarised as follows:

- Use of costly buoyancy materials such as syntactic foam are eliminated.
- Use of temporary buoyancy materials are not required during any phase of tow-out or installation.
- Aluminium conduits are light in weight, further reducing the requirement for buoyancy.

- Aluminium conduits give cathodic protection to other parts of the rigid riser structure.
- The use of flexible pipes and connections to pipelines at the riser base are eliminated. Direct pull-in of rigid flowlines and pipelines may be achieved using field proven equipment.
- The central tubular member in the rigid riser, used as a tensile structural member in former examples of hybrid risers, is eliminated. Instead, one or more export riser pipes may be included in centre of the structure.
- Tow-out and installation of the rigid riser portion can now be achieved in a single operation. The concept is also adaptable for installation from a drilling platform, or similar.
- All offshore assembly work may be eliminated.
- Hot water may be circulated through the conduits to heat the riser pipes.

C L A I M S

1. A hybrid riser configuration having a submerged tower (4) comprising a plurality of riser pipes (10) substantially inserted in guide conduits (9), and also having buoyancy means (6) and tethering tension means, the riser pipes (10) and guide conduits (9) being connected to a base (5) anchored to the ocean floor,
c h a r a c t e r i s e d i n that a plurality of the guide conduits (9) are acting as multiple tethers, each guide conduit (9) further acting as a radial constraint in elastic deformation (Euler) of the riser pipe (10) inside.

2. A hybrid riser configuration according to claim 1, c h a r a c t e r i s e d i n that the riser pipes (10) and guide conduits (9) are rigidly connected both to the base (5) and the buoyancy means (6) of the riser configuration.

3. A hybrid riser configuration according to claim 1 or 2, c h a r a c t e r i s e d i n that the material of the guide conduits (9) comprises aluminium or a similar light metal.

4. A hybrid riser configuration according to any one of the preceding claims,
c h a r a c t e r i s e d i n that it is protected by sacrificial anodes.

5. A hybrid riser configuration according to any one of the preceding claims,
c h a r a c t e r i s e d i n that during tow-out and installation, the guide conduits (9) provide necessary buoyancy to make the riser configuration, except the base (5) and buoyancy means (6), near neutrally buoyant.

6. A method for installing a riser configuration having a submerged tower (4) comprising a plurality of riser pipes (10) substantially inserted in guide conduits (9) and also having a buoyancy tank (6) and gravity base (5) connected by said riser pipes (10) and guide conduits (9), comprising the steps of:

- fabricating a bundle (4) of guide conduits (9) and riser pipes (10) on a roller bed or rail bed from which it can be launched,
- connecting the buoyancy tank (6) and gravity base (5) to opposite ends of said bundle,
- sealing at least a plurality of the guide conduits (9) and riser pipes (10) of the bundle (4),
- launching the resultant structure and connecting the buoyancy tank and gravity base ends of the structure to respective towing vessels (17) via towing wires (18),
- flooding the buoyancy tank (6) to provide it with substantial negative buoyancy so that both the tank (6) and the base (5) will act as clump weights,
- towing the structure (4,5,6) to the offshore location for its installation as a sub-surface tow while maintaining sufficient angle and tension in the towing wires (18) to maintain substantial tension in the pipe bundle (4),
- lowering the base (5) end of the structure (4-6) by paying out the towing wire connected to the base (5),
- permitting water to enter the spaces formed between the riser pipes (10) and their respective guide conduit (9) when the base (5) has reached a predetermined depth in order to limit the differential pressure across the wall of the guide conduits (9),
- continuing lowering the base end of the structure until the structure is perpendicular and suspended from the towing wire (18) connected to the buoyancy tank (6), and
- lowering the structure to allow the base (5) to penetrate the bottom (2) mud-line and anchoring the base to the ocean floor, and removing the water ballast and towing wire (18) from the buoyancy tank, thus providing tension in the guide conduits (9).

7. A method according to claim 6, wherein a motion compensating system is employed in the towing wire (18) between the buoyancy tank (6) and surface vessel (17).

8. A method according to claim 6 or 7, wherein the guide conduits (9) are fabricated by welding together sections of aluminium pipe using friction stir welding.

9. A method according to any one of claims 6-8, wherein said guide conduits (9) are made by joining sections of aluminium pipe which are made with a longitudinal seam welded by means of friction stir welding.

10. A method according to any one of claims 6-9, wherein at least some of the annular spaces between the riser pipes (10) and the corresponding guide conduits (9) are filled with a gel after expelling any water having entered said spaces during installation of the structure.

ABSTRACT

Hybrid riser configuration comprising a plurality of steel riser pipes (10) substantially inserted in aluminum guide conduits (9), with buoyancy means (6) and tethering tension means, the guide conduits (9) and the riser pipes (10) being rigidly connected to a base (5) anchored to the ocean floor. The guide conduits (9) serve as the tethering tension means and as radial constraint for the respective riser pipe (10) therein to allow the riser pipe to buckle in elastic deformation (Euler) to form a spiral when expanding due to service pressure and temperature. A method for installing the riser configuration is also disclosed.

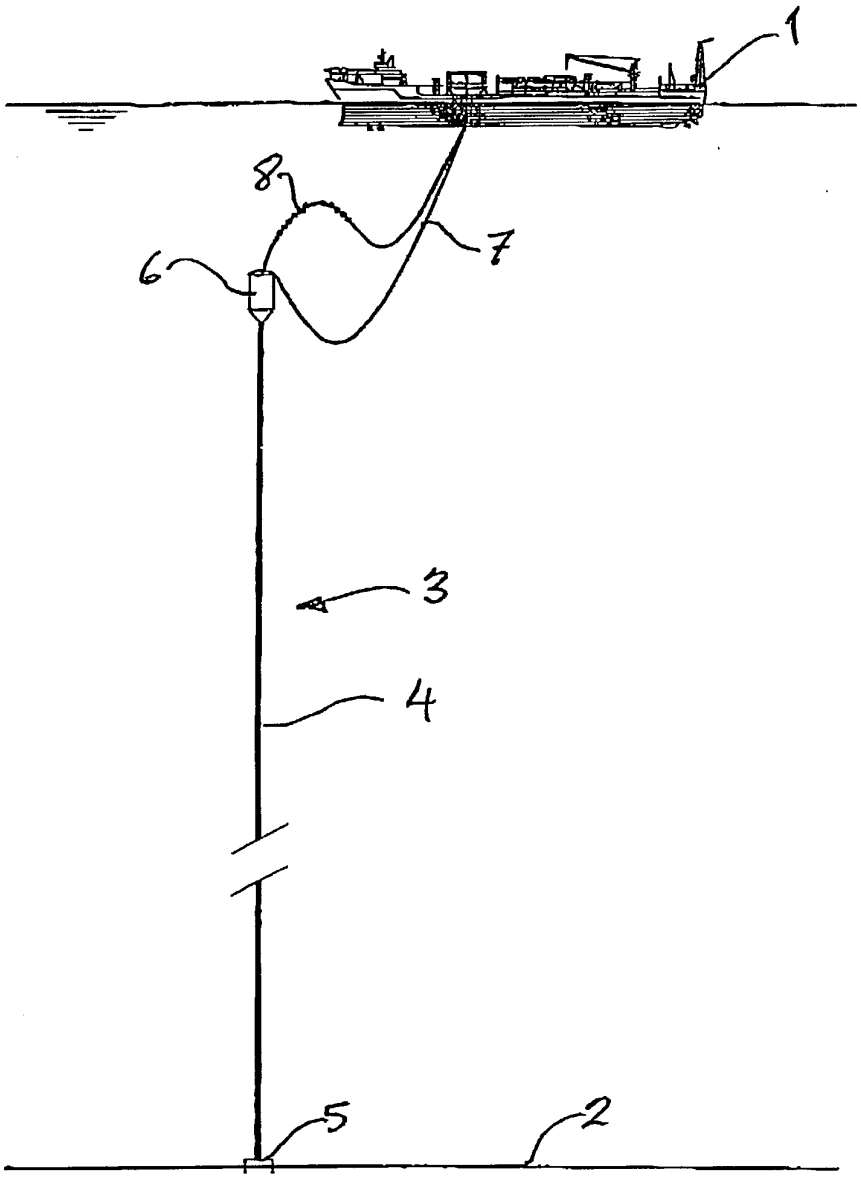


Fig. 1

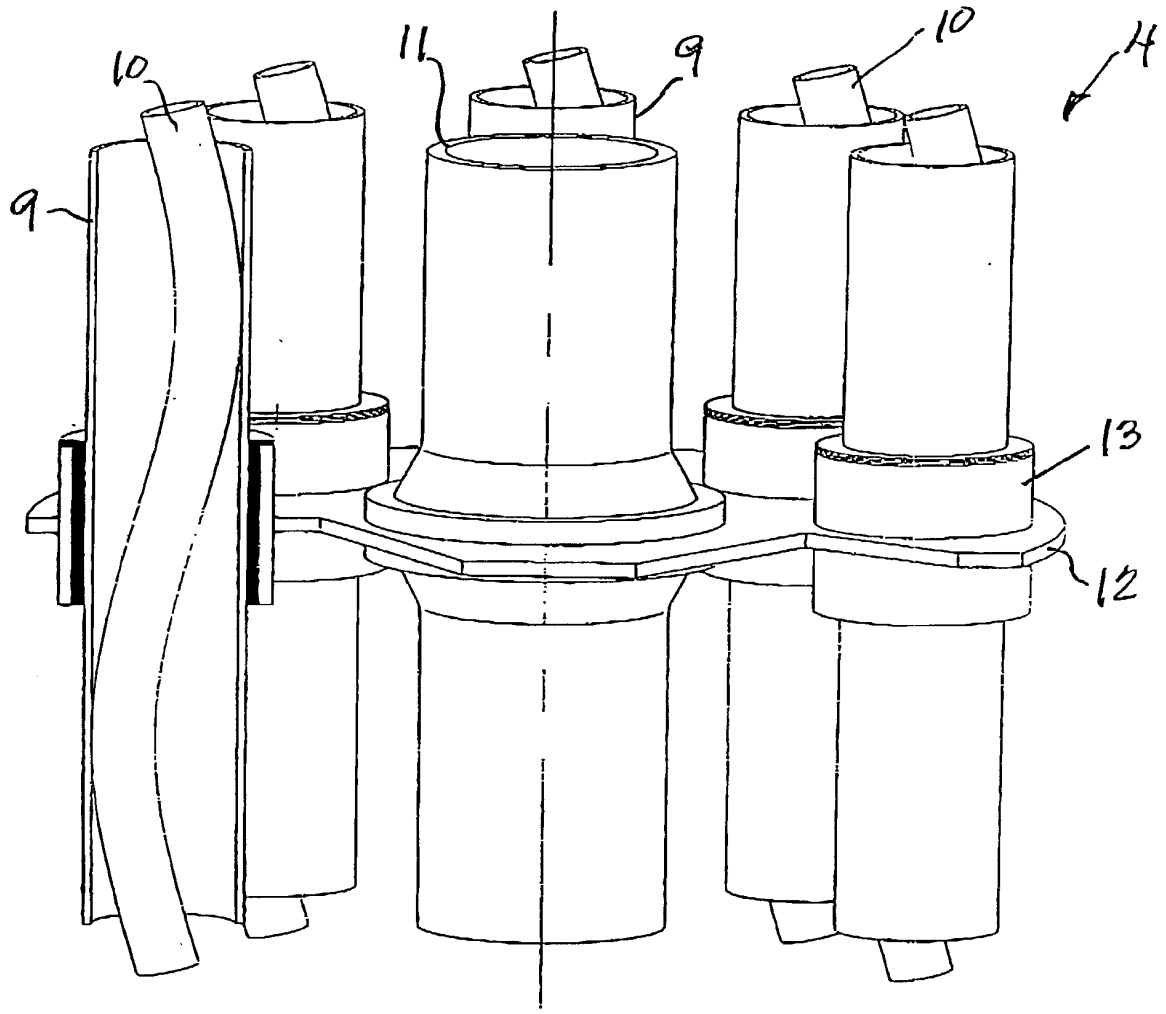
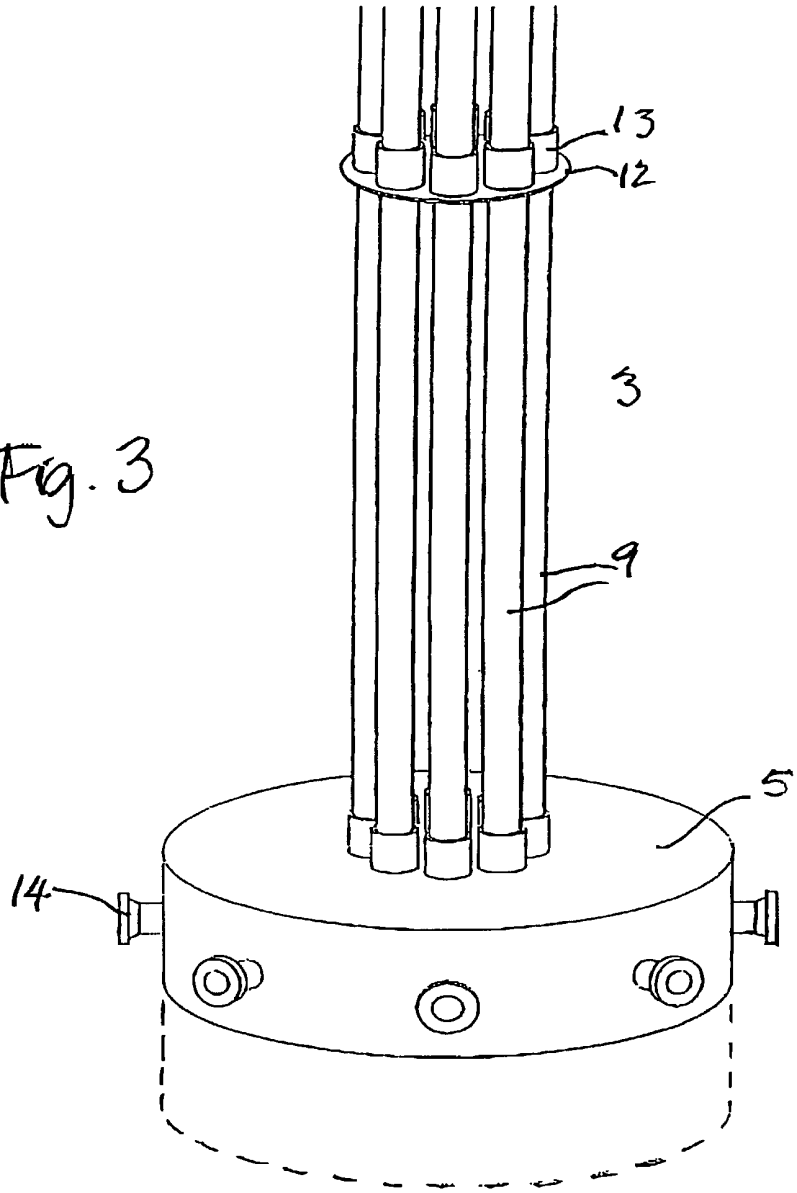


Fig. 2

Fig. 3



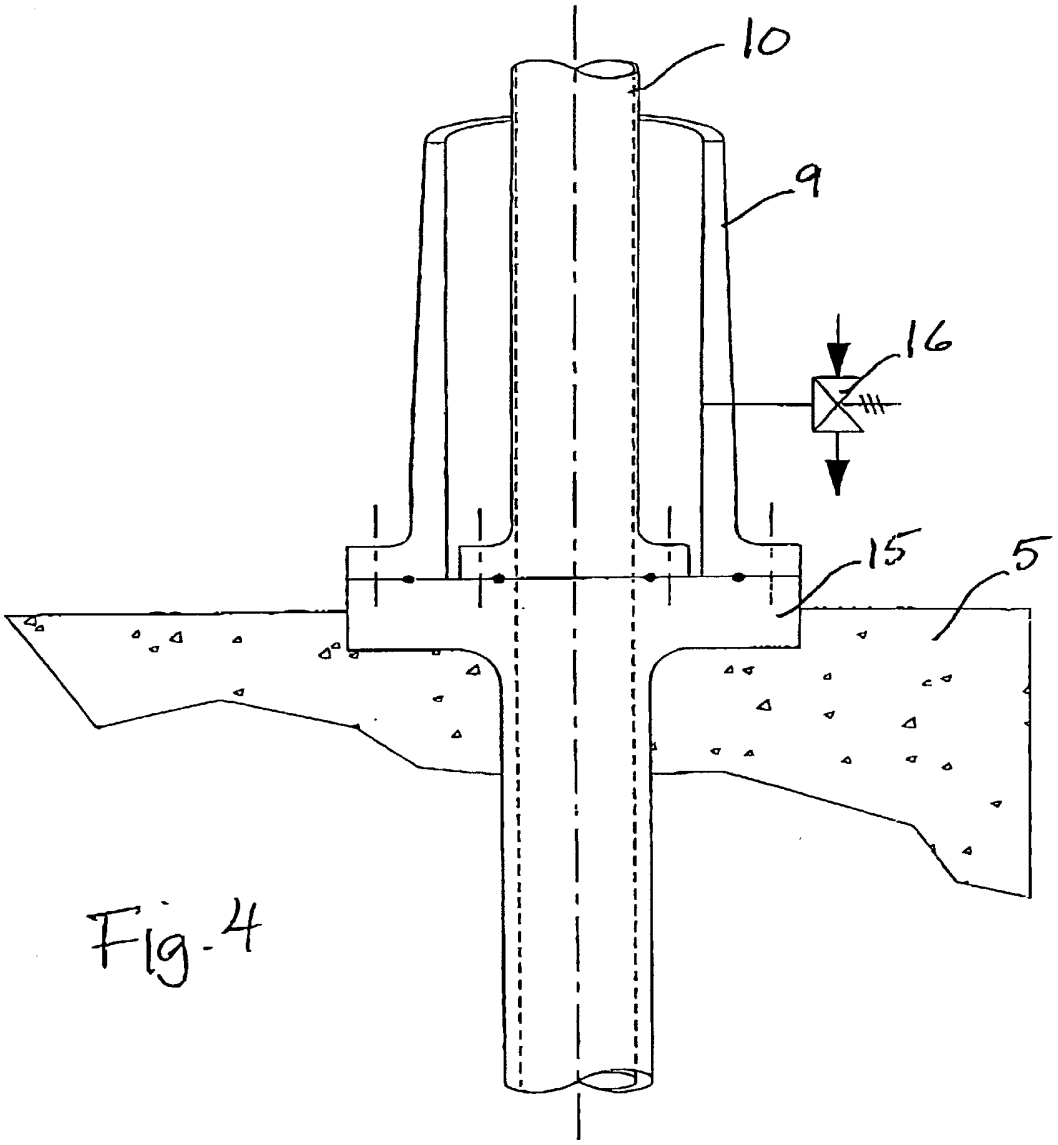


Fig. 4

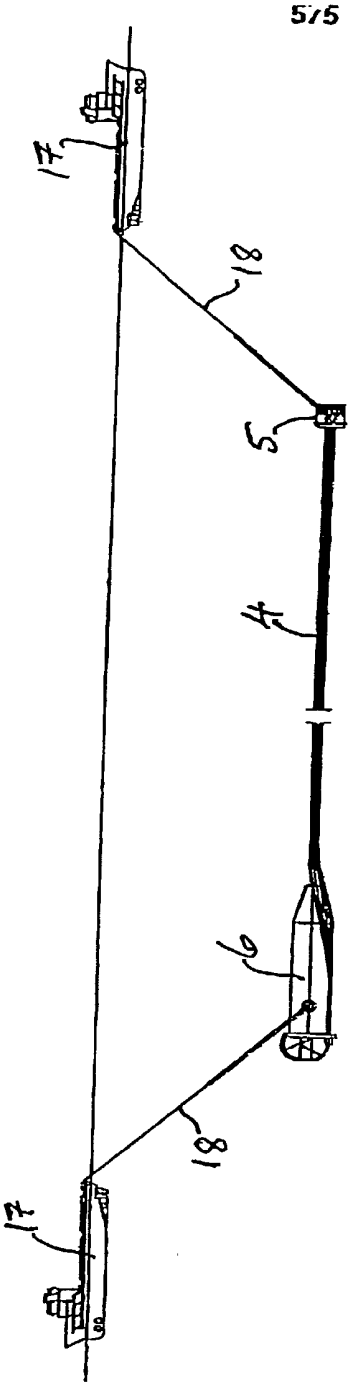


Fig. 5

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POWER OF ATTORNEY OR AUTHORIZATION OF AGENT		
	Application Number	10/069,346
	Filing Date	
	First Named Inventor	Arne Sele, et. al.
	Title	A HYBRID RISER CONFIGURATION
	Group Art Unit	
	Examiner Name	
	Attorney Docket Number	021645-000100

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☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96).

SIGNATURE of Applicant or Assignee of Record

Name	X (Magne K. Nygård) MAGNE K. NYGÅRD
Signature	X Magne K. Nygård
Date	X 15/3 - 02

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

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Attorney Docket No. 021645-000100US

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Arne Sele, et al.

Application No./Patent No.: 10/069,346 Filed/Issue Date: _____

Entitled: A HYBRID RISER CONFIGURATION

Aker Riser Systems AS, a Corporation
(Name of Assignee) (Type of Assignee, e.g , corporation, partnership, university, government agency, etc.)

states that it is:

1. ☒ the assignee of the entire right, title, and interest; or
2. ☐ an assignee of less than the entire right, title and interest.
The extent (by, percentage) of its ownership interest is _____%

in the patent application/patent identified above by virtue of either:

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☐ Additional documents in the chain of title are listed on a supplemental sheet.

☐ Copies of assignments or other documents in the chain of title are attached.
[**NOTE**: A separate copy (*i.e.*, the original assignment document or a true copy of the original document) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the USPTO. See MPEP 302.8]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

X 15/3-02
Date

X MAGNE K. NYGÅRD
Typed or printed name

X Magne K. Nygård
Signature

X Vice President
Title

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted With Initial Filing **OR** ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16(e)) required)

Attorney Docket Number	021645-000100US
First Named Inventor	Arne Sele, et. al.
COMPLETE IF KNOWN	
Application Number	10/069,346
Filing Date	
Art Unit	
Examiner Name	

As the below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name.

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A HYBRID RISER CONFIGURATION

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☐ was filed on (MM/DD/YYYY) ☐ as United States Application Number or PCT International

Application Number ☐ and was amended on (MM/DD/YYYY) ☐ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
WO 01/14687	PCT	08/24/00	☐	☐	☐
19994094	Norway	08/24/99	☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: ☐ A petition has been filed for this unsigned Inventor

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NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned Inventor

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Inventor's Signature X		X Date 15/3-02
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Tappen 12 Mailing Address			
Sandvika City	State	N-1337 ZIP	NO Country

☐ Additional Inventors are being named on the ____ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.